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Ultra Low Loss Ceramic Ribbon Waveguides for Millimeter/Submillimeter Wave

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Ever since the discovery by Kao and Hockman that ultra-low-loss optical fiber can be made from pure silica through the elimination of impurities, the ability to guide signals in the optical spectrum with very low attenuation loss is assured. There remains a spectrum from 30 GHz to 3000 GHz (called the millimeter/submillimeter (mm/submm) wave band), where low loss waveguides are still unknown. Because of the presence of inherent vibrational absorption bands in solids, the elimination of impurities is no longer the solution for finding low loss solids in this spectrum. High skin-depth loss in this spectrum also eliminates the use of highly conducting material. It appears that since the material loss factor and the dielectric constant of a solid are fixed, the only way to reduce the attenuation constant of a pure dielectric waveguide is to find the proper cross-sectional geometry of that waveguide. Here we shall report the new way to design a waveguide structure which is capable of providing an attenuation coefficient of less than 0.01 dB/m for the guided dominant mode. This structure is a ceramic (Coors' 998 Alumina) ribbon with an aspect ratio of 10:1. At operating frequency band around 100 GHz, this attenuation figure is more than one hundred times smaller than that for a typical ceramic or other dielectric circular rod waveguide, that for the traditional metallic rectangular waveguide, and that for the microstripline. Both theoretical and experimentally measured results will be shown. A new way to measure ultra-low attenuation constant for the guided wave will be described. Practical considerations, such as, low interference supports for the ceramic ribbon structure, highly efficient launching device, low-loss ceramic ribbon connections, non-radiating cornering device, etc., will also be discussed and demonstrated.

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Equipment Needed: Viewgraph